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Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

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Windmills

PUBLISHED BY
THE TEXAS COMPANY
TEXACO PETROLEUM PRODUCTS

TEXACO RECOMMENDATIONS
for Lubricating
Wood-working Machinery

BEARING LUBRICATION

As Involved on Band Saws, Planers, Shapers, Surfacers, Matchers, Moulders, etc.

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THE TEXAS COMPANY

LUBRICATION

A Technical Publication Devoted to the Selection and Use of Lubricants

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Lubrication of Woodworking Machinery

COINCIDENT with the development of means and methods for the increase of home comforts, there has been extensive practical research in the interest of perfecting the machinery necessary for the beautification of the home. The facility with which certain kinds of wood can be worked economically into most artistic designs has accelerated this trend, for demand has necessitated volume production. A variety of intricate machinery has, therefore, been developed for the molding of trim-work, sand finishing and carving of the essential parts of furniture.

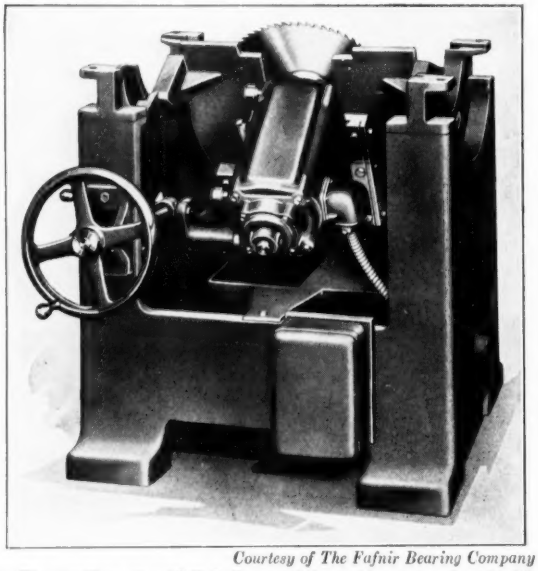
Throughout the operation of any such machinery it is obvious that the wood being handled must be protected in every way against oil spots, otherwise subsequent painting or staining might be affected. This will be especially true where sand-blast etching is to be done, or where natural grains must be preserved in finishing. In appreciation of this requirement, builders of woodworking machinery have endeavored to acquaint themselves with the advantages and limitations of the various means of automatic lubrication available, and the progress made by bearing designers relative to sealing. Knowledge of these limitations is especially essential, for it leads to better understanding of the extent to which automatic lubrication can be assured. It is also helpful in subsequent decision as to the type of lubricant which will function most effectively and with greatest economy. This latter involves not only the cost and amount of lubricants consumed, but likewise the power necessary for operation of the machinery.

It is obvious that there may often be a very direct connection between lubrication and power consumption, especially if the lubricants employed are of such nature as to give rise to abnormal drag or are unable to completely protect the moving parts. Penetration within bearing clearances, or ability to adhere to gear tooth or chain link surfaces, therefore, requires very careful consideration. This holds true, especially where improved types of mechanisms are employed involving comparatively low tolerances in operation.

The art of working wood to the many intricate shapes required today has been a development which started some 5,000 years ago, when the principle of the saw was discovered. Obviously, the saw has, therefore, played a most important part in the later perfection of saw mill and wood cutting machinery; for all wood must pass through the saw mill and be converted into boards or beams before it can be planed or shaped. These operations, in turn, have developed likewise from hand work. In contrast with sawing, they involve cutting by means of a straight knife edge.

The several stages through which the woodworking industry has passed in the development of the intricate machinery in use today have resulted in some unique devices, which

were a distinct credit to their inventors. In their application, these machines led to definite periods in the progress of perfecting wood products. Our contemporary publication, OIL-POWER* has sketched this progress in a most fascinating manner.



Courtesy of The Fafnir Bearing Company

Fig. 1—View of a Hall & Brown tilting table saw equipped with Fafnir ball bearings.

Relative lubrication, it is important to note that in this development of woodworking machinery, fixed oils of animal or vegetable origin once served as comparatively satisfactory lubricants. This was largely before the introduction of petroleum, at a time when lard and olive oils were the only products widely available. Later, whale oil, tallow, castor and rapeseed oils were also used.

Fixed or fatty oils, however, proved inadequate in the maintenance of positive and dependable lubrication, as soon as the builders perfected their means of lubrication and provided suitable housings. These latter early proved to be excellent insurance against wear and damage to moving parts, for they prevented direct entry of sawdust and other non-lubricating foreign matter. In preventing entry of such materials, these housings also prevented premature loss of lubricant through leakage. This meant that the lubricant would remain longer in service and in some cases permit of reusage. Directly this imposed an added requirement—the lubricants used must be chemically stable and show minimum tendency towards gumming. Since straight mineral oils of adequate refinement possess this property with far greater assurance than animal or vegetable oils, the latter were forthwith abandoned when the petroleum industry had proved itself. So that today one thinks of lubrication in terms of petroleum oils, or greases in which the latter predominate.

Throughout this development of lubrication it has been essential for designers of lubricating equipment to keep pace, for any lubricant can only be as dependable as its means of application. Attention has been especially directed to bearing protection, in full realization that bearings are frequently subjected to the most varying speed conditions and often have to carry considerable load under temperatures which may markedly affect the continuity of the lubricating film. Furthermore, bearings are most likely to be affected adversely by presence of non-lubricating foreign matter.

Before considering bearing design, however, it will be well to discuss the various processes involved after boards or beams have left the sawmill; likewise the operation of the machinery employed. As has been noted, we are dealing with boards, beams or deals as known to the trade. These must be planed, moulded or shaped according to the purpose for which the finish is intended. After sawing, these several processes are the most important in the woodworking industry. The general operation of the machines involved is more or less similar, and sometimes one machine can be designed to serve several purposes or perform more than one function, as for example planing on two sides simultaneously.

Planer Operation

Planing is normally the first treatment applied to a board or beam after it has left the sawmill. The purpose is to produce flat, level and more or less smooth surfaces. In order to develop the desired results, the knives or cutting tool edges are straight and operate continuously along a straight face, generally as nearly parallel to the grain of the wood as possible.

The planer is akin to the milling machine or planer in the metal working industry, with regard to its working elements. It is normally motor-driven through pulley and belt connections for speed reduction purposes. Most modern construction provides for mounting the spindles, feed rolls and certain other rotating elements on ball bearings, with pressure lubrication wherever practicable.

The Lathe

One of the earliest developments in automatic woodworking machinery involved the lathe. Its perfection was accentuated by its adaptability to turning out the wide variety of parts necessary to the building of wooden ships

*Published by the Standard Oil Company of New York. June, October and November, 1926.

when this industry was at its peak. For this reason the duty performed by the lathe is of distinct interest. As technically defined, the lathe is a device designed for production of cylindrical parts of duplicate design. Cutting is accomplished while the stock is turned or rotated, the cutting edge being fixed.

The variable speed gears employed on some types of lathes, likewise the spindle bearings which may be subject to comparatively high speeds, may present problems of lubrication, especially under more or less continuous service, or when temperatures may be extreme. Perfect alignment is, of course, highly essential; in the maintenance of this we are directly concerned with spindle bearing protection (through lubrication) and in the prevention of undue wear of gear teeth.

Moulders and Shapers

The moulder extends the function of the lathe in the development of ornamental woodwork. Virtually it is a multiple planer; as such it functions by direct cutting practically parallel with the grain of the wood. This machine is largely used for turning out trim or moulding for building purposes. It is frequently designed to cut simultaneously on all four sides of the wood, developing either straight or irregular surfaces according to the desired finish. Cutter head speeds will sometimes be comparatively high in moulder operation, especially where ball bearing mountings are used. This requires careful consideration of lubrication and the use of grease which will resist breakdown and separation. Otherwise loss of oil or formation of gummy material might result.

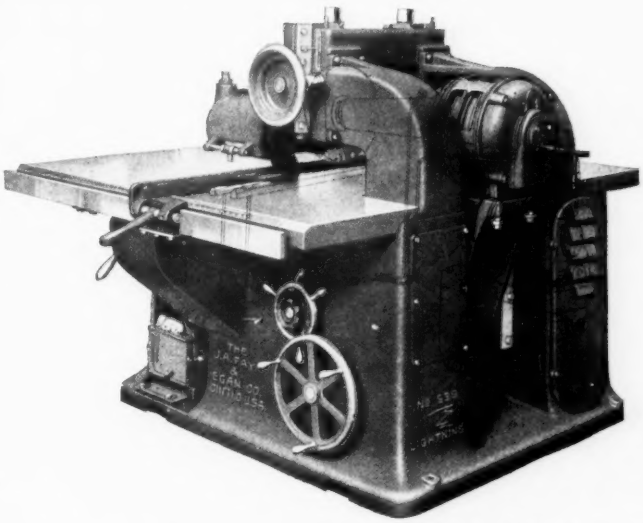
When the moulder is designed for developing irregular or curved edges along two planes, it is usually termed a shaper. The work is done by laminated cutters, frequently installed so as to function at an angle to, or across, the grain of the wood. Normally the shaper works on one of three basic principles according to whether the cutters are (1) fixed revolving spindles or holding blocks; (2) carried or fixed in a rotating disc or crosshead or (3) where the irons are fixed only, the wood being moved or fed over the cutting edges by suitable feed rolls.

Mortising and Boring

After certain types of wood products have been sawed and planed to a true surface, it is necessary to prepare them for joining. This process is widely used in the manufacture of furniture, the machine employed being known as a mortise or tenon. The cutting operation in such machines may involve either reciprocating or rotary motion, according to whether the cutting tool or chisel operates intermittently or continuously. The essential purpose is to bore holes for dowel pins. This operation of boring is very largely a multiple job, quite similar to multiple drilling in the machine shop. In wood boring one is not confronted, however, with the problem of tool lubrication and cooling.

BEARING DESIGN

The types of bearings employed in the construction of wood working machinery will depend upon the duty and speed of the parts involved. In earlier designs, before high speed production was demanded, the sleeve type bearing largely prevailed. Lubrication was generally of the unit type by means of sight feed cups or bottle oilers, or, where grease was desirable, pressure grease cups. Later the ring oiler with its more automatic features was adopted. More recently ball and roller bearings have been applied, especially on high speed mechanisms, although the unit-lubricated sleeve bearing has maintained its popularity with some builders due to the cost factor and the greater ease with which replacements can be made.



Courtesy of J. A. Fay & Egan Company

Fig. 2—A Fay & Egan electric straight line ripper, jointer and edger. Note this machine is mechanically lubricated, with oil leads from the mechanical lubricator at the lower left indicated by faint black lines. Each bearing is, therefore, fed with measured quantities of fresh oil, the supply being automatically controlled.

Higher speed operation has also been facilitated by developments in electric motor design and the adaptation of the direct connected high speed motor to operation of cutter spindles, especially on moulders and shapers. In addition to the obvious advantage of increasing the rate of production, the use of higher speeds in

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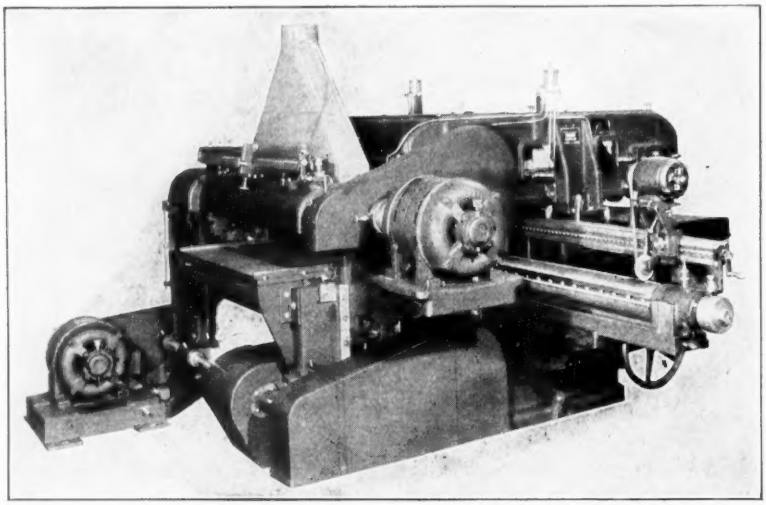
cutting operations enables the employment of cutter heads carrying fewer blades. This reduces not only the initial cost, which is especially advantageous when knives of intricate design are used, but also the labor incident to re-sharpening is materially decreased.



Courtesy of Oliver Machinery Company

Fig. 3—An Oliver Straightoplane designed for face joining lumber and planing all in one operation. Note oil cups located at top of machine with leads to essential bearings. All other bearings have provision for pressure grease lubrication.

Most recent research in the study of high speed operations has indicated that spindle speeds considerably above 15,000 r.p.m., may be readily attainable. Under such conditions normally the cutting head will carry only one blade, as compared to older types which might have from four to eight blades.

Relation of Speed to Bearing Design and Duty

In the choice of means of lubrication, the matter of speed and bearing design must be given equal consideration, along with the severity of the duty involved. There has, however, been no attempt to draw a real line between high speed and low speed service, except in the case of ball and roller bearings where some designers prefer the former for high speeds, using the roller bearing for heavier duty slow turning parts. An example of such a combination of bearings is the electrically operated planer and matcher, wherein all cutting heads and feed rolls run in ball bearings, with gear shafting carried by roller bearings.

Modern practice in construction of such equipment as a planer, moulding machine or surfacer will be also of interest. Here there is a rapidly increasing tendency to provide ball bearings for all knife head or cutting elements, using the plain or sleeve type bearing for shafting of guide rollers or similar elements where the load involved may not be as severe.

The same will hold true in saw design. Normally the band, swing or circular saw is a comparatively low speed device. In the band saw, motion is imparted by an upper and lower disc or wheel. Around these elements, the saw band is tightly stretched. Such saws are chiefly operated by individual motor drives, the electric motor being located below the saw bench and connected directly to the lower saw carrier.

The average saw in the sawmill proper is a heavy duty machine, and it must be capable of withstanding high loads and severe shocks. In the woodworking plant, however, where socalled re-sawings or cut-off work is practiced, conditions of operation will not be as severe, and frequently saw speeds may be somewhat higher.

Lubrication Assures Mass Production

It is, of course, obvious that in the handling of any woodworking machine, positive operation must be assured, for mass production in this industry has come to be virtually a by-word, and the custom in every phase of operation. To attain this objective pressure grease lubrication is extensively employed on many of the ball and roller bearings in the woodworking industry.

Grease is especially adaptable where operation in various planes may be required. The swing saw would be illustrative of this condition. It is obvious that where oil is used on such bearings there may be a possibility of inadequate lubrication, when the bearings are located in certain positions due to the oil level falling below the circulating element.

Where such bearings are designed to operate in a fixed plane, however, oil lubrication by means of wick circulation has proven quite positive and satisfactory. It is easier to control the amount of lubricant in such a bearing where oil is used than where grease is employed. This can be brought about by means of an accessory oil cup which renders it virtually impossible to raise the oil level above the top of the cup, due to the overflow tendency. An overflow or oil level control is especially desirable where wick feed lubrication may be involved, for it will prevent any possibility of abnormal oil leakage from the bearing.

Every precaution is taken today by the manufacturers of anti-friction bearings to prevent loss of lubricant by leakage. This can be accomplished by the employment of grooving or by the use of suitable felt washers, or other sealing media. This construction, of course, will also serve to prevent entry of contaminating or abrasive foreign substances. Grease as a rule will serve as a more effective bearing seal than oil. It must be borne in mind, however, that grease will tend to retain non-lubricating foreign matter to a considerable degree, although this will, of course, depend upon the consistency of the grease and the efficacy of the seal.

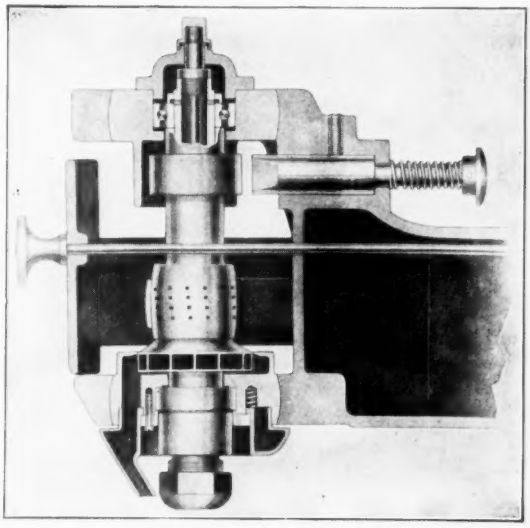
GEARS

Decision as to the type of lubricant required for the various gears essential to operation of woodworking machinery must be based on duty involved and the manner of housing. A comparatively wide range of viscosity is available in the choice of lubricants for such service, viz., the comparatively heavy bodied straight mineral type of gear lubricants necessary on exposed gears, in contrast with the very much lower viscosity oils adapted to bath lubrication. Where and when to use lubricants within this range calls for careful study. Obviously, where gears are exposed the problem of protecting contact surfaces of the teeth may become more difficult than where the gears are able to dip continually in a bath of lubricant. Furthermore, speeds must be considered; likewise the location, for the lubrication of a feed or driving mechanism may be quite different from that of an adjusting mechanism.

In the design of modern woodworking machinery, wherever practicable gears are enclosed in a relatively tight housing to enable bath lubrication. This means of lubrication is usually protective and economical, for there will be little chance of loss of lubricant through leakage, or for contamination on account of entry of sawdust or other non-lubricating foreign matter. There should normally be no difficulty in selecting a lubricant for an operation of this type, for the essential problem will be to obtain a product of adequate viscosity to meet the gear tooth pressures, and of sufficient adhesiveness to maintain a protective film on the tooth surfaces when subjected to squeezing-out action as will occur when the teeth pass in and out of mesh. Normally, a bath lubricated reduction gear installation can be effectively protected with a lubricant of approximately the viscosity of a medium steam cylinder oil; i.e., ranging from 100 to 150 seconds Saybolt Universal at 210 degrees Fahr.

Where gears are exposed, however, the essential factor is to select a lubricant which will adhere tenaciously to the teeth and will withstand the throwing-off effects of centrifugal force. One must also take into consideration the matter of sawdust. Material of this nature will be readily accumulated by the average heavy gear lubricant. Sawdust, of course, is not abrasive but it is non-lubricating. If it has a chance to become mixed with the lubricant there may be a tendency for the latter to become very heavy, and tend to ball-up and throw off, or, to accumulate between the teeth to cause a congested condition which may markedly increase power consumption, especially on cold starting.

Heavier bodied straight mineral gear lubricants are, therefore, not as preferable for the gears of woodworking machinery as the more fluid types of products which will serve to keep the gear elements free from accumulation of sawdust by virtue of their washing action. On the other hand, the matter of cleanliness must always be considered, for when the more fluid types of lubricants are used they will tend to drip. This will necessitate the use of drip pans around the machine to prevent a sloppy and hazardous condition. It is very evident that lubrication of exposed gears cannot always be economical, for any lubricant after it has dripped off a train of gears and been exposed to contaminating influences may not be in the best of condition for reusage. However, oil economy while important, must frequently give way to machine protection and the more outstanding essential of continuous production. Fortunately the gears whereon such means of lubrication may be necessary are usually of comparatively small size, and are not subjected



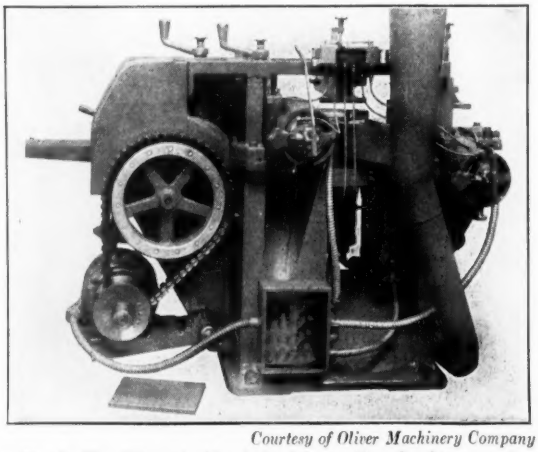
Courtesy of Onsrud Machine Works, Inc.

Fig. 4—The spindle construction of the Onsrud high speed electric router, with provision for centrifugal force feed lubrication.

to as severe load or shock during operation as would prevail on metal-working machinery of somewhat the same type.

MEANS OF LUBRICATION

The means of lubrication employed on modern sawmill and woodworking machinery are varied, according to the type and design of



Courtesy of Oliver Machinery Company

Fig. 5—The Oliver double chain drive molder showing rear view from in-feed end and means for providing automatic capillary filtered lubrication to all cutter head bearings.

the wearing elements and the duty which they perform. Five distinct types of lubricating equipment can be used, viz.:

(a) The compression grease cup or pressure grease lubricator.
(b) The mechanical force feed oiler.
(c) The individual sight feed oil cup.
(d) The wick oiler, and
(e) Bath lubrication.

All can be readily applied to bearings; in addition, bath lubrication is also used on gears and chain drives as discussed previously.

Pressure Grease Lubrication

Pressure grease lubrication applies chiefly to bearings. Opinion differs as to the relative merits of the compression cup as compared with the pressure gun. When dealing with ball or roller bearings some builders feel that more accurate control of the amount of lubricant used can be attained by use of the hand-adjusted compression grease cup. This will be especially true where the operators of such machinery may not be entirely dependable in regard to the handling of a pressure gun. It is important to remember, however, that there will very frequently be more possibility of contamination of grease with non-lubricating or abrasive foreign materials in filling a compression grease cup than where a pressure gun is used. As a general rule, the cap of the former must be entirely removed and filled by hand by means of a spoon or paddle which is dipped into the grease container. Should the machine be operating at the time, there might easily be a possibility of dirt or sawdust gaining entry. Furthermore, there is no assurance at any time that the operator or mechanic will observe the necessary care in protecting the lubricant as far as possible.

Careless handling of lubricants will subsequently react upon the bearings, and in view of the fact that but a small amount of grease is applied to an anti-friction bearing, it will not take very much non-lubricating foreign matter to do perhaps quite a considerable amount of harm. This is why many builders of anti-friction bearings prefer the pressure grease gun even though accurate control of the amount of grease delivered may not be as easily attained. On the other hand, it should not be difficult to study any type of such gun and develop an approximate idea as to the amount of grease discharged per second or per turn of the handle, according to the design. If this study is further extended to include approximate knowledge of the amount of grease required by any such bearings according to their size, over-lubrication will not be apt to occur.

In a properly designed ball or roller bearing, complete replenishment of lubricant should only be necessary about once every three or four months, or perhaps at less frequent intervals if the housing is capable of holding a relatively large volume, and design and construction are such that an effective seal is maintained.

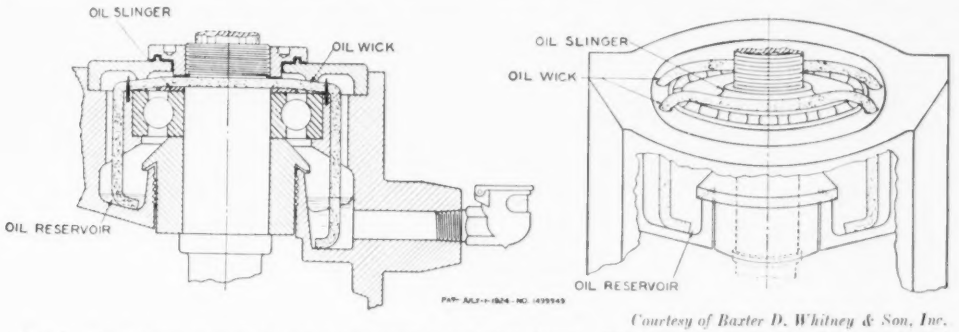
Greases as a general rule furnish better seals against entry of dust, dirt and moisture than oils, hence they protect the polished surfaces of the bearing elements in a very satisfactory manner. Greases can also be very much more effectively maintained in a non-oil-tight housing. On the other hand, dirt or grit that may find its way into a grease lubricated bearing has no means of settling out; it is always held in suspension, and probably continuously circulated in contact with the bearing elements.

The usual operating conditions attendant to anti-friction bearings in woodworking shops require that the grease used must show no tendency to separate in storage or when inactive within a bearing. Nor should this occur under moderate heating. There should be no constituent contained therein which might lead to hardening, breakdown, corrosion, pitting or rusting of bearing elements. As a result this would prohibit usage or accidental entry of sand, resin, salts or abrasives of any nature whatsoever. There should be maximum resistance to oxidation, and no ingredients should be used in manufacture which might

cause the lubricating film to become sticky or the formation of gummy residues. Finally, of course, the consistency involved should be suited to the operating requirements. Greases of buttery consistency will meet average operating conditions where the lubricant must readily cover the entire surfaces of the balls or rollers and not tend to channel in the housings or raceways.

Force Feed Lubrication

When bearings are located in inaccessible positions, as on drum sanders for example, the mechanical force feed oiler has been developed as a most positive means of assuring that oil will be delivered to a bearing or slide in just the right amount to maintain the necessary lubri-



Courtesy of Baxter D. Whitney & Son, Inc.

Fig. 6—The Whitney patented oil lubrication system as applied to shapers. This insures maximum of service from the ball bearings with minimum power consumption, for the danger of running without lubricant is practically eliminated.

cating film, and under sufficient pressure to expel any contaminating foreign matter which may have accumulated in the oil ways.

This device is chiefly used for plain bearing lubrication where bearing ends are not sufficiently sealed to assure retention of the oil, and where there is no provision for distribution of oil through the clearance spaces, other than actual capillary attraction which is brought about by the rotation of the shaft or journal. This means of lubrication assures that clean, fresh oil is delivered to the bearings at periodic intervals. Of course, there will be some oil waste through the exposed ends of the bearings, but by proper timing and adjustment of the lubricator, this amount will be so small and oftentimes so contaminated that its value will be comparatively negligible. If, in turn, pans are provided to catch any oil drip, comparative cleanliness will be assured. In this way oil spotting of wood will be prevented; likewise the rubber cushions of drum sanders will be protected.

The flexibility of the mechanical force feed oiler is clearly brought out by the duty which it is called upon to perform on the drum sander and rip saw, for example. On this latter the worm reduction gear, the cast iron links of the feed chain, and the ways or tracks over which this chain passes can be served by one such lubricator. Positive lubrication with just the right amount of lubricant is of decided importance on finishing equipment, such as the drum sander.

Lubricator Adjustment

The mechanical lubricator has a further advantage in that once it has been filled with oil and the respective oil outlets adjusted for delivery of the desired number of drops of oil per minute, no further attention will be required. This is especially true where such a device may be driven directly from the machinery which it serves to lubricate. In such a case, the lubricator only operates or pumps when the machinery itself is in operation; i.e., the starting or stopping of the latter automatically starts and stops the respective pumps of the lubricator. The speed of operation or, in other words, the number of drops delivered per minute through any of the outlets, will depend upon the speed of the machine; that is, the higher the operating speed, the more oil will be delivered.

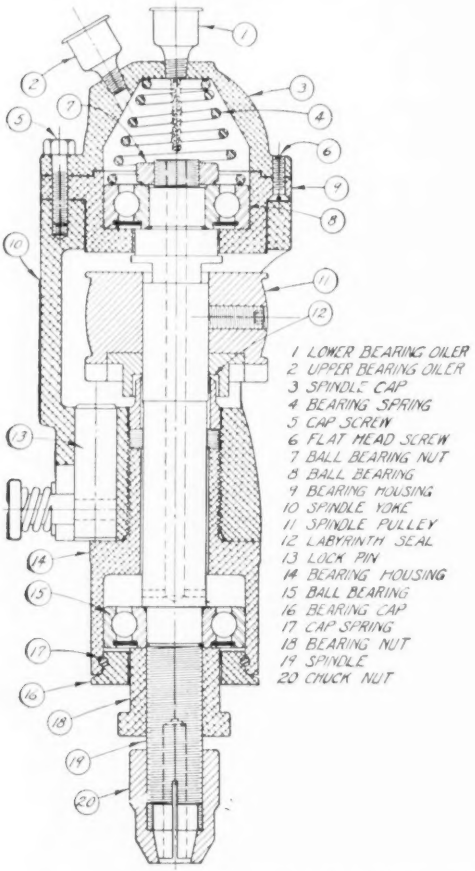
Where the lubricator is driven from an external source, as for example by an independent electric motor, more attention will be essential when starting and stopping the machine. Where mechanical lubricators are independently operated, they may require more frequent adjustment should the operating speed of the machinery to be lubricated vary to any extent.

Design

The mechanical force feed oiler will consist of a container or oil storage reservoir capable, as a general rule, of holding from one pint to two gallons of oil. The pumping element or block is located within this reservoir or attached thereto. In turn, this pumping element is provided with means whereby it can be attached to the machine to be lubricated or to an independent electric motor, through a suitable ratchet, clutch or belt connection.

There are a number of designs of lubricator

pumps. Normally they will all involve some form of plunger or piston. It is practicable to include quite a number of such pumps in the one lubricator in order to enable lubrication of as many as possible of the essential bearings, etc., from the one drive. It is furthermore practicable to divide such a lubricator into two or more parts so that more than one grade of oil can be delivered by the same device. As a general rule, however, this will not be essential in the wood-working plant.



Courtesy of Oliver Machinery Company

Fig. 7—Vertical cross sectional view through a spindle of the Oliver Minnesota carving machine, showing relative location of ball bearings and provision for lubricating both the upper and lower bearings.

Operation of the pumping element is accomplished by means of an eccentric or a cam located within the oil reservoir. This device receives its motion through the exterior operating mechanism such as the ratchet. Each pumping unit can be designed to operate independently so that individual regulation is practicable. There is generally some provision in any such lubricator for observation of flow of oil either before or after it has passed through the pumping element.

UNIT LUBRICATION

Sleeve type bearings in many cases, however, can be most economically lubricated by sight feed oil cups, wick feed cups or bottle oilers. All embody the principle of the mechanical force feed lubricator, in that they deliver fresh oil to the bearings more or less periodically, according to their design. They are also comparatively inexpensive to install.

With the exception of the sight feed type, however, they are non-adjustable, oil flow being only controlled by the size of the orifice through which it is allowed to pass to the bearing. This may or may not lead to subsequent waste, according to the frequency of oiling.

Where the orifice is comparatively large, and where the machine operator fills a cup full of oil without any thought as to the rapidity with which it will drain through the bearing, naturally the bearing may receive far too much oil and waste may develop. The sight feed oil cup, on the other hand, is capable of fairly accurate adjustment in regard to the rate at which the oil is allowed to flow through. On many types, there are also provisions for actually stopping the oil flow. This is especially advantageous when a machine is to remain inactive for any length of time, for otherwise oil would just run through the bearings, to be wasted.

Wick Feed Devices

In lubricating the types of bearings employed on high speed spindles, wick oilers have been among the appliances found to give positive and cleanly lubrication. A typical wick oiler involves periodic circulation of oil through the bearings. In connection with the shaper, a small centrifugal pump is frequently employed, being located in the lower oil reservoir. This pump serves to feed oil to the upper ball bearing via a suitable wick. From here, the oil drains to the lower bearing reservoir to be distributed by a smaller wick. After passing through this bearing there is provision for the oil to return to the pump for re-circulation.

Wick feed lubrication assures that clean oil is continually delivered to the bearings, due to the filtration effect of the wick. In addition, it is practically automatic. However, this will not hold true over the entire life of the wick, because during continued operation, should there by any possibility of entry of dust or dirt into the lubricating oil, the wick will naturally accumulate this more and more until ultimately it may become so clogged as to prevent ready flow of oil.

As a result, wicks should be removed and cleaned at regular intervals, depending upon how extensively they may become contaminated. Flow of oil may also be influenced by the number of strands used in such a wick for this will affect capillary action.

Windmills

About the time of the inception of the petroleum industry, when concerted study was being given to development of the hydraulic turbine for utilization of natural water power resources, another type of power machine—the windmill—was perfected to utilize the power of the winds in pumping water from wells.

To many the windmill is but a picturesque accessory to the average farm. To the farmer, however, it is a most effective means of pumping water automatically with minimum cost. It is therefore ornamental as well as useful.

The most practicable windmill, of course, is the one which will run most easily in light winds, for it is under such conditions that the water supply must be most regularly replenished. Any type of wind wheel with the crudest type of wind sails will turn in a high wind. Operation under light breeze conditions, however, calls for coordination in wind sail design and motor mechanism construction. The latter must be especially studied from the viewpoint of friction reduction. It is an error to assume that since the device must function outdoors parts can be assembled without thought as to their relation to each other. This leads to serious power losses in overcoming friction, to noise, and abnormal wear regardless of lubrication. Hence the design of the modern windmill motor to enable positive lubrication and the use of precision methods in manufacturing and assembling parts.

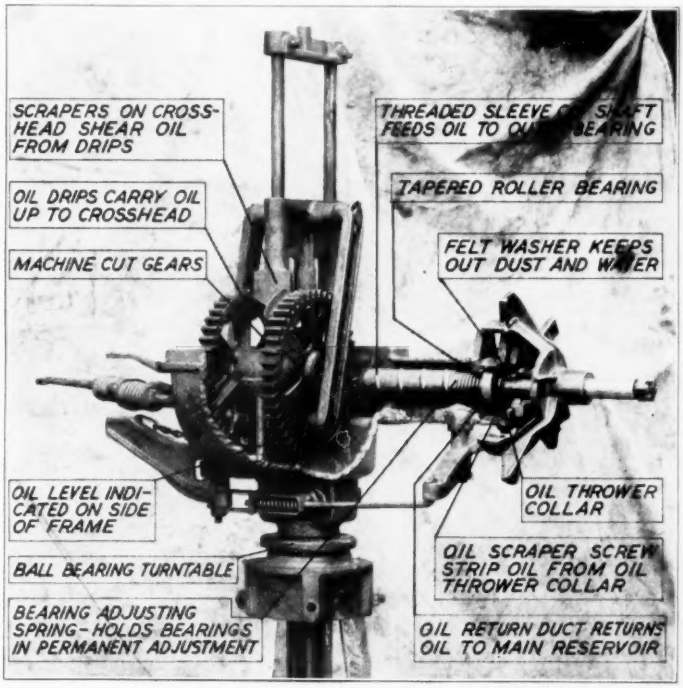
WIND MOTOR DESIGN

The motor mechanism of the modern windmill is distinctive for its simplicity. It involves an assembly of gears so designed with respect to an eccentric or differential as to develop up and down motion in one or more pitmans or connecting rods. This motion, in turn, is passed on to the pump piston or plunger. The normal stroke is from six to eight inches, although longer strokes are practicable on heavy duty installations. The stroke in inches is equivalent to the diameter of the wind wheel in feet.

Wind power is transmitted by the rotating wind wheel through a main shaft fitted with one or two pinions at the driving end. Each pinion meshes with a large main gear which drives a pitman. Where differential action is employed, double pinion, gear and pitman rod assemblies are necessary; the lower end of each pitman being pivoted to its companion large gear at a point near the rim. This design is claimed to assure of equalization of load. When an eccentric mechanism is used, however, the wind wheel shaft is fixed to only one pinion, which meshes with an internal gear. This latter, in turn, is designed to rotate an eccentric ring which converts the rotary motion of the gear to the up-and-down reciprocating motion necessary in the piston rod. This design eliminates the necessity for guide rods and rollers to maintain pitman alignment. Instead, a rocker arm is used, hinged on a pin at one end and connected to the piston rod at the other. In this design an extension at one side of the eccentric ring serves as the pitman, being connected to the rocker arm above.

PARTS CONSTRUCTION

The general assembly of parts required to make up a wind motor includes spur gears, sleeve or anti-friction bearings and sliding elements, such as the eccentric ring or the pitman guides.

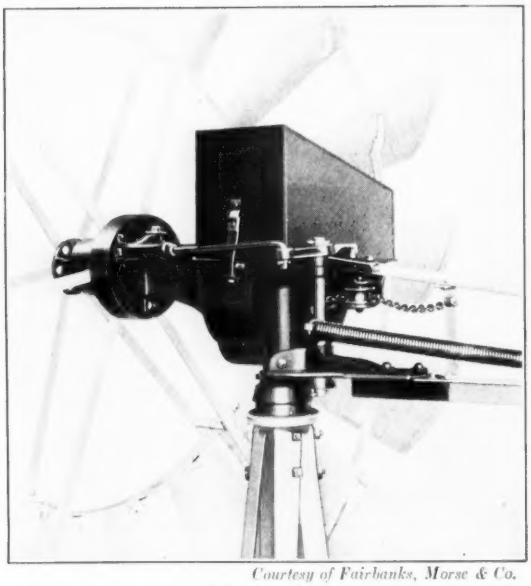

SCRAPERS ON CROSS-HEAD SHEAR OIL FROM DRIPS
OIL DRIPS CARRY OIL UP TO CROSSHEAD
MACHINE CUT GEARS
OIL LEVEL INDICATED ON SIDE OF FRAME
BALL BEARING TURNTABLE
BEARING ADJUSTING SPRING-HOLDS BEARINGS IN PERMANENT ADJUSTMENT
TAPERED ROLLER BEARING
FELT WASHER KEEPS OUT DUST AND WATER
OIL THROWER COLLAR
OIL SCRAPER SCREW STRIP OIL FROM OIL THROWER COLLAR
OIL RETURN DUCT RETURNS OIL TO MAIN RESERVOIR

Courtesy of Dempster Mill Manufacturing Co.

Fig. 8 — Cutaway view of the assembly of the Dempster wind motor. Note that gears run constantly in a bath of oil with provision for automatic circulation.

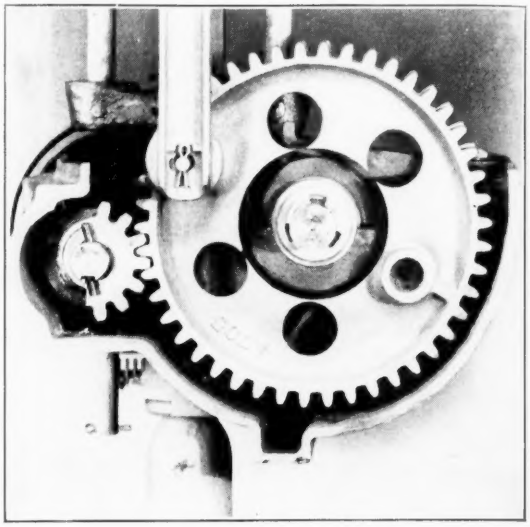
Gear Design

The spur gear has been found to be the most



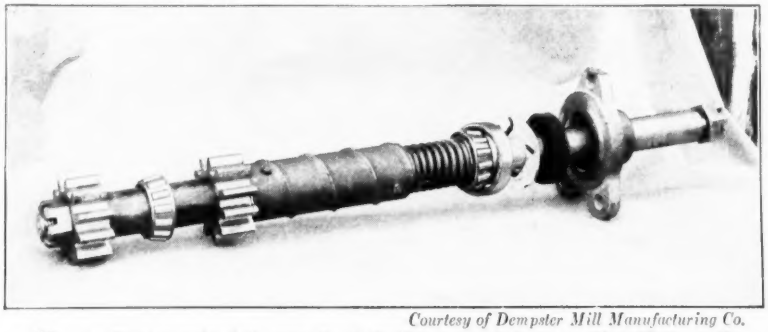
Courtesy of Fairbanks, Morse & Co.

Fig. 9—Exterior view of the Fairbanks, Morse Eclipse windmill, showing braking mechanism and manner of housing wind motor.



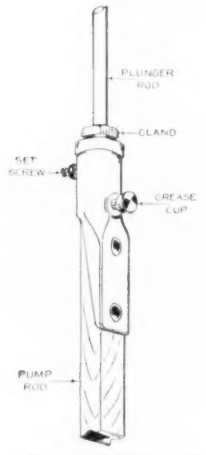
Courtesy of Aermotor Company

Fig. 10—Gear assembly of an Aermotor wind motor, showing removable bearings and relative location of the gears with respect to pitman.



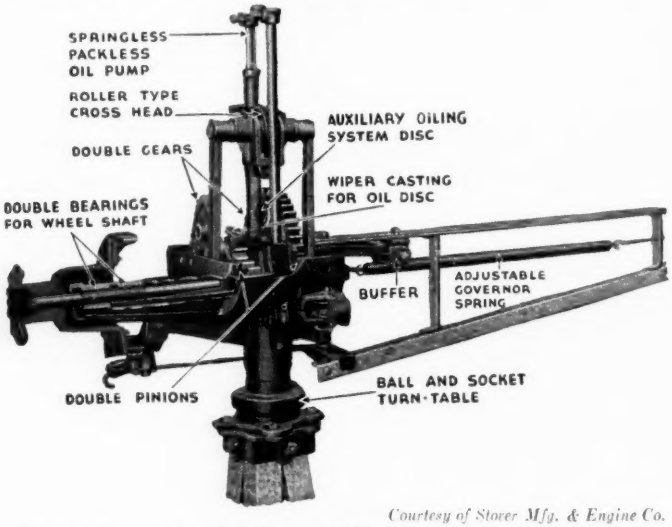
Courtesy of Dempster Mill Manufacturing Co.

Fig. 11—Showing main shaft assembly of the Dempster wind motor. Note Timken roller bearings and automatic take-up spring which compensates for bearing wear.



Courtesy of Challenge Co.

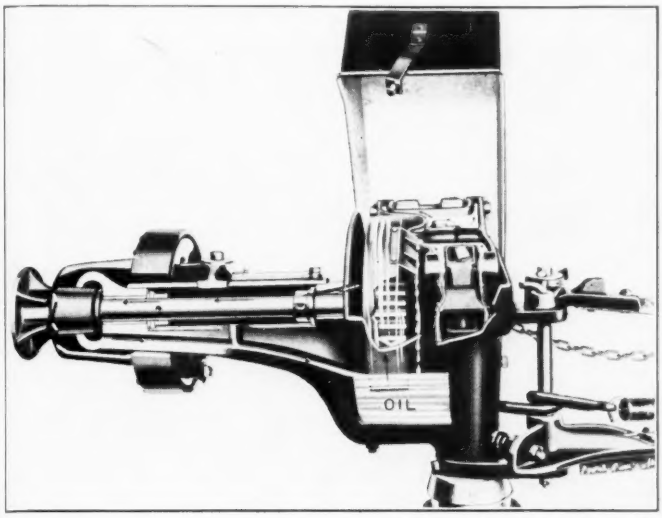
Fig. 12—The Challenge pump rod swivel which is equipped with a closed grease chamber capable of holding at least one year's supply of lubricant. Note location of grease cup.



Courtesy of Stover Mfg. & Engine Co.

Fig. 13—Cutaway view of the Samson Oil-Rite windmill motor with essential parts plainly indicated. The automatic lubricating system on this unit starts and stops with the operation of the mill, to thereby deliver a positive flood of oil to the moving parts at all times. This oil is continuously recirculated by a unique type of pump wherein one of the guide rods consists of a hollow steel tube which forms a pump cylinder. By use of a suitable companion plunger there is always assurance that oil is pumped to the highest point of the mechanism, from whence it flows by gravity to all bearings and gears.

practicable and durable as the primary power transmission element. As already indicated, either external or internal design is used. The external gear, with teeth spaced around the rim, is usually a cast unit, for the sake of economy and durability. Where the gear teeth are located internally, however, they may be either cast or cut. More teeth of the pinion are in mesh with an internal gear than an external. According to the principles of gear design, this provides more positive protection against damage to the teeth and adds strength to the unit. The same results can be obtained with an external gear assembly, however, by deeper meshing and due consideration of pitch and tooth width to bring about increased contact between the teeth when in mesh.



Courtesy of Fairbanks, Morse & Co.

Fig. 14—Phantom view showing how completely the Fairbanks, Morse new Eclipse windmill motor is oiled.

Bearings

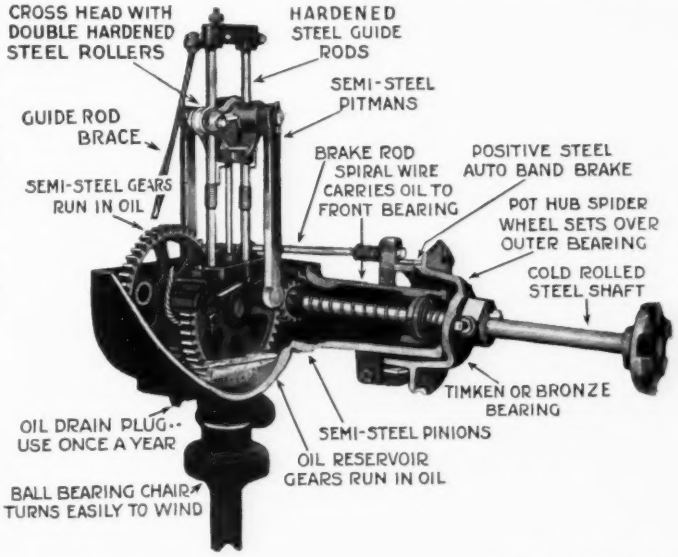
Both the sleeve type bearing and the roller or ball bearing can be used to carry the various shafting and rods employed in a wind motor assembly. The sleeve type bearing is normally lower in first cost; furthermore, it can be more easily replaced. To offset this, however, the roller or ball bearing reduces the friction element. Once installed, if design is correct, both should function indefinitely provided they are properly lubricated.

Some builders use the two-piece sleeve type bearing, and machine the contact surfaces to enable maximum reduction of friction, with better assurance of free oil circulation. Others use babbitted surfaces, especially for the gear shaft bearings and pitman connections.

Regardless of bearing design, however, it must be remembered that the surfaces in contact are being continually flood lubricated, hence possibility of bearing troubles due to abrasion are markedly reduced. In addition, the enclosed oil-tight nature of the motor case and housing effectively prevents entry of abrasive dust, even when exposed to the dust storm conditions so prevalent in some parts of the west.

Sliding Surfaces

These are involved between the eccentric and eccentric ring on some types of motors, and on the pitman guides on others. Lubrication here likewise is by splash or flood, the contact surfaces usually receiving far more oil than is necessary for actual lubrication. This distribution of oil is maintained by oil slinger rings, suitable grooves cut on the driving pinion, and spiral oil conveyors. It is a credit to the designing engineers that these means for oil distribution to parts above the oil bath in the gear case have afforded excellent protection of all the parts involved, to reduce the cost of parts replacement to a minimum. The only


CROSS HEAD WITH DOUBLE HARDENED STEEL ROLLERS
HARDENED STEEL GUIDE RODS
SEMI-STEEL PITMANS
GUIDE ROD BRACE
BRAKE ROD SPIRAL WIRE CARRIES OIL TO FRONT BEARING
POSITIVE STEEL AUTO BAND BRAKE
SEMI-STEEL GEARS RUN IN OIL
POT HUB SPIDER WHEEL SETS OVER OUTER BEARING
COLD ROLLED STEEL SHAFT
TIMKEN OR BRONZE BEARING
OIL DRAIN PLUG-- USE ONCE A YEAR
SEMI-STEEL PINIONS
OIL RESERVOIR GEARS RUN IN OIL
BALL BEARING CHAIR TURNS EASILY TO WIND

Courtesy of Challenge Co.

Fig. 15—The Challenge windmill motor is also designed for automatic circulation of oil. On this machine the main casting forms the oil reservoir. The hub of the pinion nearest the wheel has three spiral grooves. At each revolution oil is drawn to a spiral oil conveyor and carried to the front bearing under the hub of the wheel.

proviso is regular renewal of the oil charge, which is usually recommended at yearly intervals.

LUBRICATION

Self-lubrication is a feature of the modern windmill motor or pump driving mechanism. Noteworthy progress has been made by the various builders over recent years in planning their designs for automatic circulation of oil within the motor housing to all bearings, gears and sliding surfaces. The principles of flood lubrication have been followed whereby an excess of oil is constantly flowing over all these parts. This serves a double purpose in that both lubrication and cooling is maintained. The latter may become an important feature in very warm, dry weather, or where considerable wind velocity prevails, when the motor may be called upon to operate at high speed for considerable periods of time.

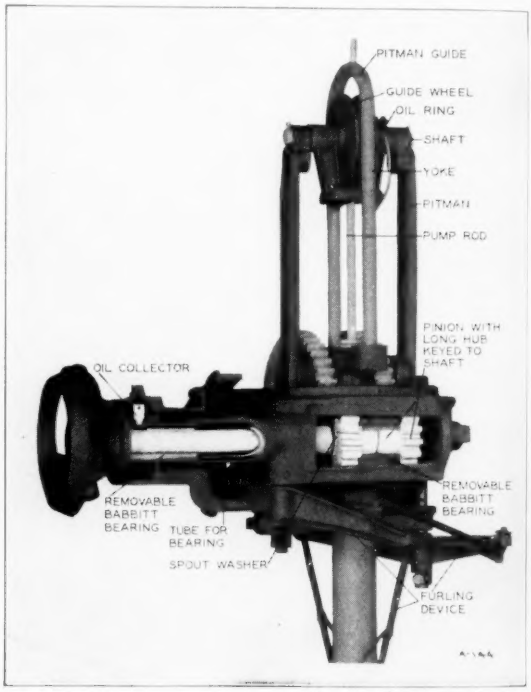
By reason of these requirements and the type of construction, the oil used must have very definite characteristics; obviously it must be able to maintain a protective film on the gear teeth at all times, regardless of unit tooth load; at the same time it must flow readily through bearing clearances. So, oil film tenacity, along with fluidity, over the entire range of operating temperatures, is highly desirable.

At the same time the oil must be chemically stable and resistant to breakdown or oxidation. Otherwise gummy residues might develop to impair circulation of the oil and slow up the motion of the rolling elements in a ball or roller bearing.

Experience has proved that use of a straight mineral, wholly distilled type of oil, having a viscosity of around 100 to 150 seconds Saybolt Universal at 100 degrees Fahr., will meet these conditions. If this oil, in addition, is of a straw to light amber color it will show a low carbon residue test, which is an adjunct should high temperatures be encountered. Finally, if the oil is selected in accordance with its ability to flow readily at 0 degrees Fahr., it will show the least tendency to congeal and slow up operations when the mill is operating in winter. This property of fluidity is distinguished by a low pour test; consequently this requirement for such service should be specified as being 0 degrees Fahr., or below.

Grease Lubricated Parts

Grease is only required in windmill operation on the pump rod swivel. This element is usually built with a grease chamber capable of holding a supply sufficient for several months operation. Application is made by grease cup or pressure gun, using a water resistant type of semi-solid grease which will withstand oil separation and oxidation.



Courtesy of Aermotor Company

Fig. 16—Parts assembly of the Aermotor windmill motor showing relative location of moving elements, the oil collector for the shaft and the removable babbitt bearings. This design also provides for continuous circulation of oil to all moving parts.

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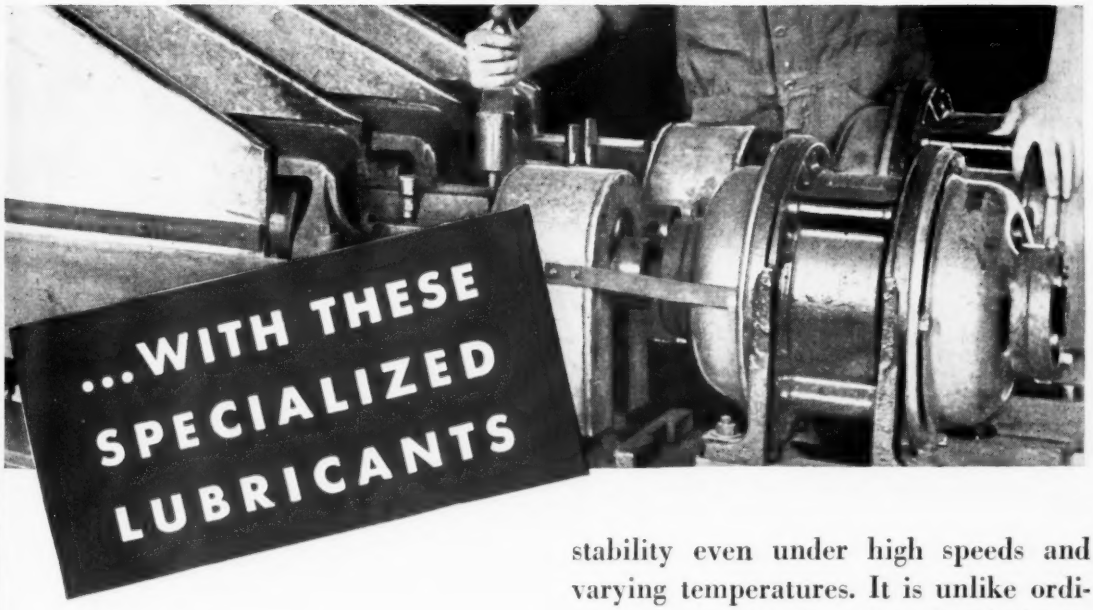

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A Texaco representative will be glad to provide practical engineering service to prove the economies of Texaco Starfak.

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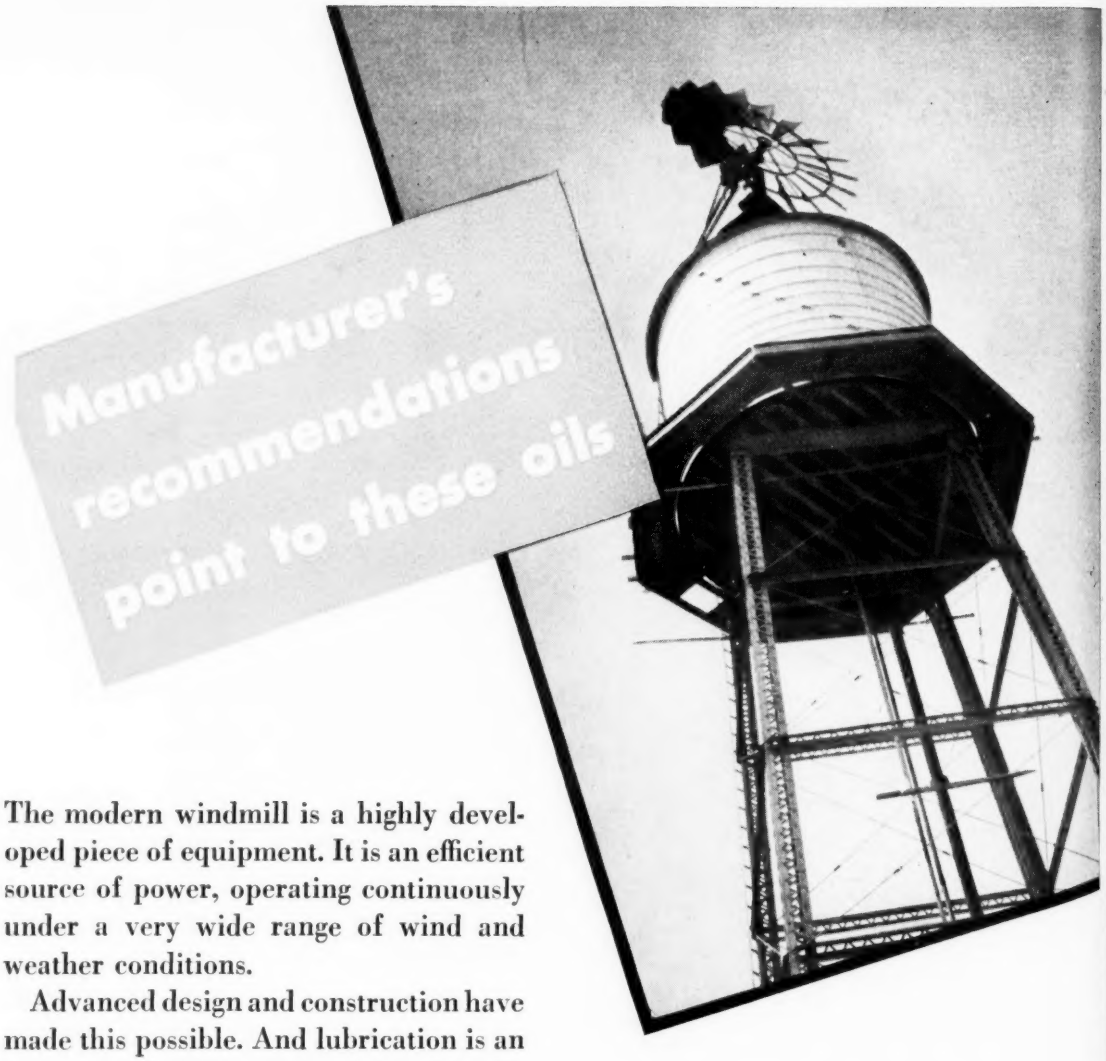

The modern windmill is a highly developed piece of equipment. It is an efficient source of power, operating continuously under a very wide range of wind and weather conditions.

Advanced design and construction have made this possible. And lubrication is an important factor in maintaining this efficiency, lowering the maintenance cost and attention.

In cooperation with builders, Texaco is giving its service in solving the problems of lubrication . . . providing lubricants that maintain their effective qualities under all possible operating extremes over long periods.

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